Instruction Manual

Type 5623

Gauss Impulse Multiplier

BRÜEL & KJÆR

B K

Apparatus for teletechnical, acoustical and vibrational research

Address: Brüel & Kjær, 2850 Nærum, Denmark · Telegrams: BRUKJA, Copenhagen, Telex 5316 · Telephone: 80 05 00 · Postgiro No. 66226

B K

Gaussian Impulse Multiplier
Type 5623

A multiplier with gaussian and rectangular functions for weighting tape and digitally recorded signals that are reproduced for analysis as repetitive analogue signals. Weighting selects only the signal portion of interest whilst rejecting repetition irregularities and unwanted signals that interfere with analysis. Manual and automatic signal "strobing" facilities are provided for analysis of signal development on amplitude, frequency, time scales.

5623 CONTENTS

1. INTRODUCTION AND SPECIFICATIONS (PRODUCT DATA)

2. CONTROLS

    2.1 Front Panel
    2.2 Rear Panel

3. OPERATION

    3.1 Installation
        Mounting
        Mains Voltage and Fuse Selection
        Signal-Chassis Ground Selection.

    3.2 Weighting Digitally Recorded Signals

    3.3 Weighting Tape Recorded Signals

    3.4 Signal Strobing

    3.5 Adjustable Weighting Widths

    3.6 Use of Auxiliary socket
        Remote Increment Step-Reset
        Trigger Output

4. EFFECT OF TIME WEIGHTING FUNCTIONS

2. CONTROLS.

2.1 FRONT PANEL.

Fig. 2.1 Front Panel of the 5623.

POWER SWITCH:	"On" - "Off" switch for the internal connection of a main supply connected at the MAINS INPUT socket on the rear panel of the Multiplier.
POWER INDICATOR:	An opal indicator lamp which lights when the Multiplier is connected to a mains supply and its POWER SWITCH is set to "On".
TRIGGER LEVEL:	Single turn potentiometer regulating the level and therefore instant the Multiplier is activated by an external trigger signal (pulse or sinusoidal burst) applied at the TRIGGER INPUT socket on the rear panel of the instrument.
TRIGGER SLOPE:	Two switches determining the type of signal that may be used to activate the Multiplier fixed delay when applied to the TRIGGER INPUT socket on the rear panel. The switch functions are: "Slow". The Multiplier may be triggered using a 400 Hz to 20 kHz sinusoidal signal burst of amplitude between 150 mV and 35 Vpk with duration exceeding 100 ms. Applicable with tape recorded data such as that recorded with a7003 or 7004 Tape Recorder.See section 3.3.

"Fast". A TTL (Transistor-Transistor Logic) compatible pulse (i.e. 0 to 0,5 V for logical "0" and 2,5 to 5 V for logical "1") exceeding 50 μs duration may be used to trigger the Multiplier. Applicable with digitally recorded data such as that recorded with the 7502 Digital Event Recorder. See section 3.2.

"+". The Multiplier is triggered by the positive edge of the external TTL trigger pulse.

"-". The Multiplier is triggered by the negative edge of the external TTL trigger pulse.

FIXED DELAY CONTROLS: Two ten position switches and a ten turn potentiometer with lock for selection and adjustment of fixed delays between 0 and 10 s. The fixed delay is triggered when a sinusoidal signal burst or TTL pulse is applied to the TRIGGER INPUT socket of the Multiplier and is used to fix the relative position (time axis only) of the Multiplier weighting function with respect to the signal to be multiplied, applied at the SIGNAL INPUT socket on the rear panel.

FIXED DELAY LED: A light emitting diode which lights each time the Multiplier is triggered and the fixed delay is operative.

INCREMENT SELECTOR: Ten position switch for selection of delay increments between 0,2 and 200 ms. Depending on the INCREMENT LIMIT switch setting on the rear panel up to 99 delay increments may be added to the end of the fixed delay so that each time the Multiplier fixed delay is triggered the position of the Multiplier weighting function is displaced one extra increment in time with respect to the signal to be multiplied.

INCREMENT MODE:	Two position switch operative when the INCREMENT STEP switch on the rear panel is set to "Int". The switch has the following functions: "Man". The Multiplier may be manually stepped adding the next delay increment by pressing the STEP push button on the front panel when the FIXED DELAY LED or WINDOW LED is alight. "Auto". The Multiplier is automatically stepped adding the next delay increment each time the Multiplier fixed delay is triggered.
INCREMENT STEP:	Push button for manually stepping the Multiplier to the next delay increment when the INCREMENT MODE switch on the front panel is set to "Man" and the INCREMENT STEP switch on the rear panel is set to "Int".
INCREMENT RESET:	Push button for manually resetting the encrement multiplier to zero when the INCREMENT RESET switch on the rear panel is set to "Int". Overrides automatic reset and therefore may be used to reset the multiplier before the maximum number of delay increments set by the INCREMENT LIMIT SWITCH is reached.
INCREMENT MULTIPLIER LEDS:	Two rows of light emitting diodes which light indicating the factor by which the delay increment selected with the INCREMENT SELECTOR switch must be multiplied to obtain the total incremental delay added to the fixed delay.
INCREMENTAL DELAY LED:	A light emitting diode which lights after the FIXED DELAY LED has been extinguished, indicating when the incremental delay is operative.

CLOCK:

Two position switch with the following functions:

"Int." An internal 1 MHz clock signal is connected for selection of Gaussian and rectangular weighting width increments using the WINDOW WIDTH switch.

"Ext." An external sine or square wave clock signal with frequency between 15 Hz and 1 MHz and voltage between 1 and 10 V peak to peak may be applied to the EXT. CLOCK socket on the rear panel for continuous adjustment of gaussian and rectangular weighting window widths as in section 3.5.

WINDOW WIDTH:

Ten-position switch for selection of gaussian weighting half amplitude window widths between 1 and 2000 ms when the CLOCK switch is set to "Int". With rectangular weighting, window widths between 3 and 6000 ms may be selected. i.e. multiply knob indication by 3.

Note: The weighting function-gaussian or rectangular is selected using SIGNAL MULTIPLIER switch on the rear panel.

WINDOW LED:

A light emitting diode which lights after the INCREMENT DELAY LED has been extinguished, indicating that the gaussian or rectangular weighting function window of the Multiplier is operative multiplying the signal applied at the SIGNAL INPUT SOCKET: The multiplied signal is made available at the SIGNAL OUTPUT socket on the rear panel.

2.2. REAR PANEL.

Fig. 2.2〉 Rear Panel of the 5623.

SIGNAL MULTIPLIER:	Two position switch for selection of gaussian and rectangular weighting functions. The input signal applied to the SIGNAL INPUT socket is multiplied by the function selected, so that the portion of signal in time coincidence with the function is made available at the SIGNAL OUTPUT socket of the Multiplier.
INCREMENT MULTIPLIER LIMIT:	Ten position switched marked in decade steps from 10 to 90 limiting the number of delay increments that may be added to the fixed delay before increment multiplier is automatically reset to zero. An "Off" position is also provided in which the maximum number of delay increments that can be added is 99.
INCREMENT MULTIPLIER STEP - RESET:	Two switches whereby the increment multiplier may be stepped and reset Internally via the INCREMENT MODE. "Auto" - "Man" switch or Externally via the AUXILIARY socket.

Immediately below the Increment Multiplier controls are six BNC sockets. These accept the BNC to BNC connection cables AO 0089 and the BNC to B&K connection cables AO 0064 supplied, and have the following functions:

SIGNAL INPUT:	BNC socket for application of the signal to be multiplied by the gaussian or rectangular shaped window function of the Multiplier. The input impedance is approximately 60 kΩ.

SIGNAL OUTPUT:	BNC socket providing an output of the signal applied at the SIGNAL INPUT socket that has been multiplied by the gaussian or rectangular weighting function of the Multiplier to select the required portion of signal for analysis. The output has an output impedance of less than 5Ω , but should not be loaded by less than 10 KΩ. The maximum open circuit output voltage is 2,5 V peak.
TRIGGER INPUT:	BNC socket for application of an external trigger signal(sinusoidal signal burst or TTL pulse depending TRIGGER MODE switch setting) to trigger the Multiplier weighting function. The trigger signal is delayed internally by the fixed and incremental delay selected on the Multiplier.
TRIGGER OUTPUT:	BNC socket providing a TTL pulse with logical 1 corresponding to the active period of the rectangular weighting function. The pulse may be used to trigger an oscilloscope for display of the input signal and weighted output signal of the Multiplier.
GAUSS. OUTPUT:	BNC socket providing an impulse corresponding to the gaussian weighting function of the Multiplier for display on an oscilloscope. The output should not be loaded by less than 10 kΩ. With open circuit output the maximum output voltage is approximately 10 V peak.

EXT. CLOCK:	BNC socket for application of an external clock signal to control the width of the gaussian or rectangular weighting function of the Multiplier. The clock signal should be a sine or square wave function of amplitude between 1 and 10 V peak to peak and frequency between DC and 1 MHz. See section 3.5 .
AUXILIARY:	DIN socket accepting the 7 pin plug JP 0703 supplied for connection of external control and display equipment. For connections and applications of the socket, see section 3.6 .
MAINS VOLTAGE SELECTOR AND FUSE:	Selects correct mains voltage. On delivery the central knob of the selector is fitted with a 350 mA slow blow mains fuse for operation from a 100 to 240 V (50 to 400 Hz) AC mains supply. To remove the fuse unscrew the black central knob and pull straight out. To change the mains voltage selector setting, remove the fuse and pull the black bush straight out. Re-insert the bush so that its pin fits into the socket corresponding to the correct voltage.
MAINS INPUT:	Input socket accepting the Power Cable AN 0010 provided for connection os a mains supply as shown in Fig. 2.3. Note verify the MAINS VOLTAGE SELECTOR setting before connecting the supply.

Fig 2.3) Connection of mains supply to MAINS INPUT socket.

3. OPERATION

The operation given here concerns the use of the 5623 for gaussian and rectangular weighting of tape and digitally recorded signals that are reproduced for analysis as repetitive analogue signals. For information concerning the analysis of weighted signals the B & K Application Note "Frequency Analysis of Stationary, Non-stationary and Transient Signals" is available on request.

3.1 INSTALLATION.

3.1.1 Mounting.

The 5623 is designed to fit into the B & K Module System shown in Fig. 3.1. Its metal cabinet is the Modular Unit KK 0024 which may either be used free standing on its four rubber feet or when fitted to the Metal Frame KK 0014 may be mounted together with a combination of other instruments in the module system. For mounting the instrument combination into a 19 inch instrumentation rack the Flanges KV 1037 may be fitted to the frame or where a more rugged instrument combination is required the frame may be fitted with the Mahogany Case KA 0027.

For further information on the module system the KA, KK, KQ and KS Assembly Manual should be consulted.

Fig. 3.1 The B & K Module System

3.1.2 Mains Voltage and Fuse Selection.

Before use of the 5623 check that the fuse rating and voltage setting of the VOLTAGE SELECTOR on the rear of the instrument is suitable for operation with the mains supply voltage about to be connected on delivery the instrument is fitted with a 350 mA slow blow fuse (B&K stock no. VF 0009) suitable for operation from a 100 to 240 V (50 to 400 Hz) AC mains supply.

To change the fuse unscrew and pull out the black central knob of the VOLTAGE SELECTOR. To select the mains voltage pull the black voltage selector bush behind the knob straight out and re-insert the bush so that its pin fits in the slot corresponding to the correct voltage setting.

Once the fuse and mains voltage setting have been checked the mains supply may be connected to the MAINS INPUT socket using the Power Cable AN 0010 provided. To fit a suitable mains plug to the cable, see Fig. 2.3.

3.1.3 Signal-Chassis Ground Selection

Hum pick-up by ground loops can cause considerable measurement inaccuracies. To prevent this it is essential that the 5623 and other instruments with which it is used are properly grounded. This can be done as follows:

1. Connect the signal ground lines of all instruments together. This is done automatically through the screen of coaxial cables connecting the input and output sockets of the instruments.

2. Connect the signal ground of one of the instruments to its chassis and then connect the chassis to mains ground. It is essential that this is done on only one of the instruments and preferably the one nearest the measurement source.

3. Make the necessary adjustments such that the chassis of each of the other instruments is connected to one and only one of the following: a) mains ground, b) signal ground, or c) chassis ground of another instrument which must eventually be connected to mains ground.

On delivery the signal ground and chassis ground of the 5623 are connected with the CHASSIS switch of the instrument set to its 'On' position(ie,away from rear panel). If necessary the switch may be set to 'Off'(ie,towards rear panel) disconnecting the signal ground from chassis, so as to suit the above grounding requirements. The CHASSIS switch is situated in one corner of the main printed circuit board on the underside of the 5623. It is accessible after having removed the instrument's bottom cover, fastened by the thumb screw on the front panel.

3.2 OPERATION WITH DIGITAL RECORDERS

The use of the 5623 to weight signals that have been recorded digitally for analysis as a repetitive analogue signal is given here with reference to the B & K Digital Event Recorder Type 7502. A similar procedure may be used with other types of Digital Recorder which like the 7502 have a separate TTL (Transistor-Transistor Logic) compatible logic 1 pulse for triggering the 5623 on each repetition of the record signal.

Fig. 3.2) Instrument set-up using the Gaussian Impulse Multiplier Type 5623 to weight an analogue signal recorded with the Digital Event Recorder Type 7502.

To gate signals recorded with the 7502 using the 5623 proceed as follows:

1. Record the signal to be weighted using the 7502.

2. With the OUTPUT SELECTOR of the 7502 set for repetitive playback, set the OUTPUT SAMPLE RATE and REPETITION DELAY controls of the instrument to obtain a suitable repetition time for analysis of the recorded signal.

   The repetition time can be calculated using the following relation:

   $$t_r = M_s \, t_s \, (1 + M_r)$$

   where t_r is the repetition time of the recorded signal on playback (s)

   M_s is the multiple indicated by the MEMORY SIZE LEDs.

   t_s is the sweep time (per 2k memory) setting of the OUTPUT SAMPLE RATE control (s). If the "OUTPUT RATE/1000" pushbutton is depressed multiply by 1000 to obtain t_s

   M_r is the multiple selected with REPETITION DELAY control.

   Since the repetition delay of the 7502 is produced before each sweep of the recorded signal, care must be taken to ensure that the signal portion to be analyzed starts not more than 10 s after the start of each repetition cycle. If this period is exceeded the signal portion will be outside the range of the FIXED DELAY controls of the 5623.

3. Playback the recorded signal and connect the 7502 to the 5623 as shown in Fig. 3.2.

4. Using the SIGNAL MULTIPLIER switch on the rear panel of the 5623 select the appropriate weighting function:

   "Gauss" for analysis of continuous signals or parts of complete signals.

   "Rect" for analysis of complete short duration signals such as shocks and impulses.

5. With the FIXED DELAY controls of the 5623 set for zero delay and the CLOCK MODE switch set to "Int", select a "half amplitude width" with the WINDOW WIDTH switch that is close to one tenth of the signal repetition time t_r calculated in item 2.

6. Set the POWER switch of the 5623 to "On", setting slider switches INCREMENT STEP-RESET to "Int" and INCREMENT MODE to "Man". If INCREMENT MULTIPLIER LEDs other than "0 x 1" and "0 x 10" are lit, press the INCREMENT RESET push button.

7. Connect a double beam Oscilloscope as shown in Fig. 3.2. This is used to monitor the signal to be weighted as well as the selected weighting function. The gaussian function is available at the GAUSS. OUTPUT on the 5623, whilst the rectangular function is available at the TRIGGER OUTPUT.

8. Set the Oscilloscope TIME BASE switch to a time/division approximately one fifth of the signal repetition time t_r calculated in item 2. Other controls on the Oscilloscope should be set as follows:

CHANNEL SELECTOR	"Ch 1 and Ch 2"
CHANNEL SENSITIVITY	" 2 V/division"
CHANNEL COUPLING	"DC"
TRIGGER MODE	"Ext"
TRIGGER COUPLING	"DC"
TRIGGER SLOPE	"Positive"
POWER	"On"

9. With the TRIGGER SLOPE switches of the 5623 set to "+ Fast" gradually turn the TRIGGER LEVEL control counter clockwise from position "max". Stop turning the instant the FIXED DELAY, INCREMENTAL DELAY AND WINDOW LEDs commence to flash indicating that the 5623 is triggered.

10. Adjust the Oscilloscope TRIGGER LEVEL controls to obtain a steady display. As shown in Figs. 3.3(a-b) and 3.4 (a-b) the weighting function should be repeated once for each repetition of the signal to be weighted. If not, readjust the TRIGGER LEVEL control on the 5623 to obtain correct triggering.

Fig. 3.3) Gaussian weighting of a continuous signal
a) Continuous signal before weighting
b) Gaussian weighting function of 5623
c) Continuous signal after gaussian weighting

Fig. 3.4) Rectangular weighting of shock or impulse
a) Shock or impulse before weighting
b) Rectangular weighting function of 5623
c) Shock or impulse after rectangular weighting

11. Adjust the FIXED DELAY controls of the 5623 so that the position of the weighting function displayed on the Oscilloscope corresponds with the start of the signal portion of interest.

12. Using the WINDOW WIDTH switch on the 5623 set the width of the weighting function as follows:

    "Gaussian". Half amplitude width t_G not greater than one third of the signal period t_S. See Fig. 3.3 (a-b)

    "Rectangular". Width t_W slightly greater than signal period t_S. See Fig. 3.4 (a-b)

    To adjust for gaussian weighting half amplitude widths between 1 and 2000 ms and rectangular weighting widths between 3 and 6000 ms an external clock signal may be used as in section 3.5.

13. Disconnect Ch-2 INPUT on the Oscilloscope from the GAUSS or TRIGGER OUTPUT socket and connect it to the SIGNAL OUTPUT socket on the 5623, so that the unweighted and weighted signals are displayed on the Oscilloscope. See Fig. 3.3 (a-c) and 3.4 (a-c).

14. Using the FIXED DELAY potentiometer, fine adjust the position of the weighting function so that the weighted signal displayed on the Oscilloscope corresponds to the signal portion of interest. To prevent signal discontinuity errors it is necessary to ensure that the rise and decay slopes of the rectangular weighting function correspond with the zero crossings of the signal.

If the length of the weighted signal is very short, trigger the Oscilloscope from the TRIGGER OUTPUT of the 5623 and set the Oscilloscope TIME BASE switch so that only the weighted signal is displayed.

15. Apply the weighted signal to the analysis instrumentation.

3.3 OPERATION WITH TAPE RECORDER

The use of the 5623 to weight tape recorded signals for analysis is given here with reference to B & K Tape Recorders Types 7003 and 7004. A similar procedure may be used with other types of Tape Recorder provided that these accept tape loops and have a multi-channel record/reproduce capability.

Fig. 3.5⟩ Instrument set-up using the Gaussian Impulse Multiplier Type 5623 to weight a signal recorded with Tape Recorder Type 7003 or 7004.

To weight a tape recorded signal using the 5623 proceed as follows:

1. Record the signal to be analyzed onto a spool of recording tape using record channel Ch 1 of the Tape Recorder.

   At the same time record with no input signal on record Ch 2. This will erase previously recorded data leaving record Channel Ch 2 free for later recording of a sinusoidal marker burst for triggering the 5623.

2. Locate the portion of tape on which the signal to be analyzed is recorded, measure its overall length in inches and form it into a tape loop. Tape loops may be fitted onto a 7003 or 7004 Tape Recorder using Tape Loop Cassette UD 0035.

   To make a successful tape loop where the splice joining the ends of the tape is as "silent" as possible, the use of a professional tape splicing machine together with a high quality splicing tape is recommended.

3. Fit the tape loop onto the Tape Recorder and using record channel Ch 2 record a short sinusoidal marker burst over the tape splice for triggering the 5623.

The marker burst may be obtained from the output of a Beat Frequency Oscillator such as Type 1022 or 1024 when this is momentarily connected to the input of record channel Ch 2 using an external self resetting push button switch.

To help position the burst over the splice it should be recorded with the lowest tape speed selected. On playback at the tape speed to be used for analysis it should be approximately 0,1 s long and should occur between 0,1 and 9,9 s before the portion of signal to be analyzed. Also the frequency of the burst should be between 400 Hz and 20 kHz with amplitude between 15 mV and 35 Vpk.

4. Playback the tape loop at the tape speed to be used for analysis and calculate the approximate repetition time of the loop using the relation:

$$t_r = \frac{l}{t_a}$$

where t_r is the repetition time of the tape loop (s)

l is the length of the tape loop (in)

t_a is the tape speed used for analysis (in/s)

5. Connect the Tape Recorder to the 5623 as shown in Fig. 3.5

6. Using the SIGNAL MULTIPLIER switch on the rear panel of the 5623 select the appropriate weighting function:

"Gauss" for analysis of continuous signals or portions of complete signals

"Rect" for analysis of complete short duration signals such as shocks or impulses.

7. With the FIXED DELAY controls of the 5623 set for a 0,1 s delay and the CLOCK MODE switch set to "Int" select a "half amplitude width" with the WINDOW WIDTH switch that is close to one tenth of the tape loop repetition time t_r calculated in item 4.

8. Set the POWER switch of the 5623 to "On", setting slider switches INCREMENT STEP-RESET to "int" and INCREMENT MODE to "Man". If INCREMENT MULTIPLIER LEDs other than "0 x 1" and "0 x 10" are lit, press the INCREMENT RESET push button.

9. Connect a double beam Oscilloscope as shown in Fig. 3.5. This is used to monitor the signal to be weighted as well as the selected weighting function. The gaussian function is available at the GAUSS. OUTPUT on the 5623, whilst the rectangular function is available at the TRIGGER OUTPUT.

10. Set the Oscilloscope TIME BASE switch to a time/division approximately one fifth of the tape loop repetition time t_r calculated in item 4. Other controls on the Oscilloscope should be set as follows:

CHANNEL SELECTOR	"Ch 1 and Ch 2"
CHANNEL SENSITIVITY	"2 V/division"
CHANNEL COUPLING	"DC"
TRIGGER MODE	"Ext"
TRIGGER COUPLING	"AC"
TRIGGER SLOPE	"Positive"
POWER	"On"

11. With the TRIGGER SLOPE switches of the 5623 set to "+ Slow" gradually turn the TRIGGER LEVEL control counter slockwise from position "max." Stop turning the instant the FIXED DELAY, INCREMENTAL DELAY AND WINDOW LEDs commence to flash indicating that the 5623 is triggered.

12. Adjust the Oscilloscope TRIGGER LEVEL controls to obtain a steady display. As shown in Figs. 3.3 (a-b) and 3.4(a-b) the weighting function should be repeated once for each repetition of the signal to be weighted. If not, readjust the TRIGGER LEVEL control on the 5623 to obtain correct triggering.

13. Adjust the FIXED DELAY controls of the 5623 so that the position of the weighting function displayed on the Oscilloscope corresponds with the start of the signal portion of interest.

14. Using the WINDOW WIDTH switch on the 5623 set the width of the weighting function as follows:

"Gaussian"	Half amplitude width t_G not greater than one third of the signal period t_S. See Fig. 3.3(a-b).
"Rectangular"	Width t_W slightly greater than signal period t_S. See Fig. 3.4(a-b)

To adjust for gaussian weighting half amplitude widths between 1 and 2000 ms and rectangular weighting widths between 3 and 6000 ms an external clock signal may be used as in section 3.5.

15. Disconnect Ch 2 INPUT on the Oscilloscope from the GAUSS or TRIGGER OUTPUT socket and connect it to the SIGNAL OUTPUT socket on the 5623, so that the unweighted signals are displayed on the Oscilliscope. See Figs. 3.3(a-c) and 3.4(a-c).

16. Using the FIXED DELAY potentiometer, fine adjust the position of the weighting function so that the weighted signal displayed on the oscilloscope corresponds to the signal portion of interest.

    To prevent signal discontinuity errors it is necessary to ensure that the rise and decay slopes of the rectangular weighting function correspond with the zero crossings of the signal.

    If the length of the weighted signal is very short, trigger the Oscilloscope from the TRIGGER OUTPUT of the 5623 and set the Oscilloscope TIME BASE switch so that only the weighted signal is displayed.

17. Apply the weighted signal to the analysis instrumentation.

3.4 SIGNAL STROBING

When a non-stationary signal is recorded for reproduction and analysis as a repetitive signal, interference from repetition irregularities and noise may be eliminated using the rectangular weighting function of the 5623. However, if the signal is too long to be analyzed as a whole (exceeds 6s - maximum width available with rectangular weighting), then it must be split up into segments for separate analysis. An efficient means of doing this without introducing signal zero crossing errors is to weight the signal using the gaussian weighting function of the 5623 stepping the function along the time axis of the signal using the incremental delay multiplier of the instrument. This technique is known as signal strobing and is illustrated in Fig. 3.6.

Fig. 3.6) Signal "strobing" using the incremental delay multiplier of the 5623 to step the gaussian weighting function along the time axis of a recorded signal

With the incremental delay multiplier there are three methods of strobing a recorded signal:

1) Manual stepping of the gaussian weighting function using the INCREMENT STEP push button when slider switches INCREMENT MODE and INCREMENT STEP are set to "Man" and "Int."

2) Automatic stepping of the gaussian weighting function after each repetition of the recorded signal when slider switches INCREMENT MODE and INCREMENT STEP are set to "Auto" and "Int".

3) Remote stepping of the gaussian weighting function by applying a TTL logic "0" pulse to the AUXILIARY socket when slider switch INCREMENT STEP is set to "Ext". Permits automatic strobing when digital readout instrumentation is used for analysis. See section 3.6 .

Depending on the setting of the INCREMENT LIMIT switch the gaussian function may be stepped up to 99 times before the increment multiplier is automatically reset. With each step the function is delayed by one of ten delay increments which may be selected with the INCREMENT SELECTOR switch. The overall incremental delay which is added to the end of the fixed delay is therefore the delay increment selected multiplied by the number of steps indicated by the INCREMENT MULTIPLIER LEDS. The maximum incremental delay obtainable is 19,8s, meaning that signals as long as 20 s may be strobed.

For adequate signal coverage when strobing it is recommended that the INCREMENT SELECTOR switch is set for a delay increment less than half the gaussian function half amplitude width. False triggering may be prevented by ensuring that the maximum number of steps or increments selected with the INCREMENT LIMIT switch is less than:

$$N \leqslant \frac{t_r - t_f}{t_D} - 3$$

where N is the number of delay increments t_D that may be added to the fixed delay t_f without exceeding the repetition time t_r of the recorded signal.

When the incremental delay reaches the number of increments set with the INCREMENT LIMIT switch the increment multiplier is automatically reset for zero incremental delay. To reset before the limit is reached press the INCREMENT RESET pushbutton after having set the INCREMENT RESET slider switch to "Int".

For further information on spectrum strobing the B & K Application Note "   " is available on request.

3.5 ADJUSTABLE WEIGHTING WIDTHS

When the required weighting function width falls between the preset values selectable with the WINDOW WIDTH switch the width may be adjusted using an external clock oscillator. This should produce a sine or square wave signal of between 1 and 10 V peak to peak and may be connected to the EXT. CLOCK socket on the rear panel of the 5623 when the CLOCK MODE switch is set to "Ext". Adjustment of the oscillators frequency from 15 Hz to 1 MHz adjusts the gaussian function half amplitude width from 1 ms to 2 s and the rectangular function width from 3 ms to 6 s. To ensure correct smoothing of the functions the WINDOW WIDTH switch should be set to a width just greater than that actually required.

3.6 USE OF AUXILIARY SOCKET

The AUXILIARY socket accepts the 7 pin DIN plug (B & K stock no. JP 0703) supplied and has the pin identities shown in Fig. 3.7.

Fig. 3.7 Auxiliary socket (external view)

3.6.1 Remote Increment Step and Reset

For remote operation of the increment multiplier of the 5623 set the slider switches INCREMENT MULTIPLIER STEP-RESET to "Ext". To remotely step the multiplier to the next increment apply a TTL compatible "logic 0" pulse (i.e. 0 to + 0,5 V) to pin 6 of the AUXILIARY socket, whilst to reset it to zero apply the pulse to pin 3 or short pin 3 to ground pin 2. For automatic spectrum strobing both functions may be controlled using a Bruel& Kjaer/ Varian Computer Type 7504.

3.6.2 Trigger Output

For control of digital readout instrumentation two TTL compatible pulses corresponding to the active period of the rectangular weighting function window are available at the AUXILIARY socket. That available at pin 5 is a logic 0 pulse between 0 and 0,4 V, whilst that at pin 4 is a logic 1 pulse between 2,4 and 5 V. For spectrum strobing applications involving the use of the Real Time Third Octave Analyzer Type 3347 the logic 1 pulse may be used to automatically reset the "Store Max." mode of the Analyzer when this is fitted with the printed card WB 0085 that is available on special order.

4. EFFECT OF TIME WEIGHTING FUNCTIONS

Time weighting functions can be used with advantage in eliminating noise and repetition discontinuities with signals that are recorded for analysis as repetitive analogue signals. However, care must be taken to ensure that the correct form of weighting is used as otherwise the frequency spectrum of the signal will be altered preventing accurate analysis. To illustrate this point the time and frequency domain descriptions of a continuous cosine wave before and after weighting by rectangular and gaussian weighting function are given in Figs. 4.1 and 4.2.

Fig. 4.1 Effect of rectangular weighting function on a continuous cosine wave
a) Continuous cosine wave
b) Rectangular weighting function
c) Cosine wave multiplied by rectangular weighting function

Comparison of Figs. 4.1 and 4.2 show that both types of weighting alter the frequency spectrum of the cosine wave but only the rectangular function has an appreciable influence. This is due to the steep rise and decay slopes of the function causing a sharp discontinuity at the beginning and end of the multiplied waveform when not in time coincidence with the zero crossings of the cosine wave. The discontinuities introduce a large number of frequency components not present in the original cosine wave and these show up in analysis reducing the resolution. With gaussian weighting there is little influence on the analysis resolution as the rounded slopes of the weighting function nullify any discontinuity introducing fewer frequency components.

Fig. 4.2 Effect of gaussian weighting function on a continuous cosine wave.
a) Continuous cosine wave
b) Gaussian weighting function
c) Cosine wave multiplied by gaussian weighting function

A method of avoiding waveform discontinuities with the rectangular weighting function is to adjust the fixed delay and weighting function width (see section 3.5) so that the rise and decay slopes of the function coincide with the zero crossings or zero axis of the signal to be weighted. This makes the rectangular function ideal for weighting complete short duration signals such as shocks or impulses, but not for weighting continuous signals or small parts of complete signals where the function is used to "strobe" the signal along its time axis. In this case the use of the Gaussian weighting function is to be prefered.

For further information on the effect of time-weighting functions the B & K Application Note "Frequency Analysis of Stationary, Non-Stationary and Transient Signals" is available on request.

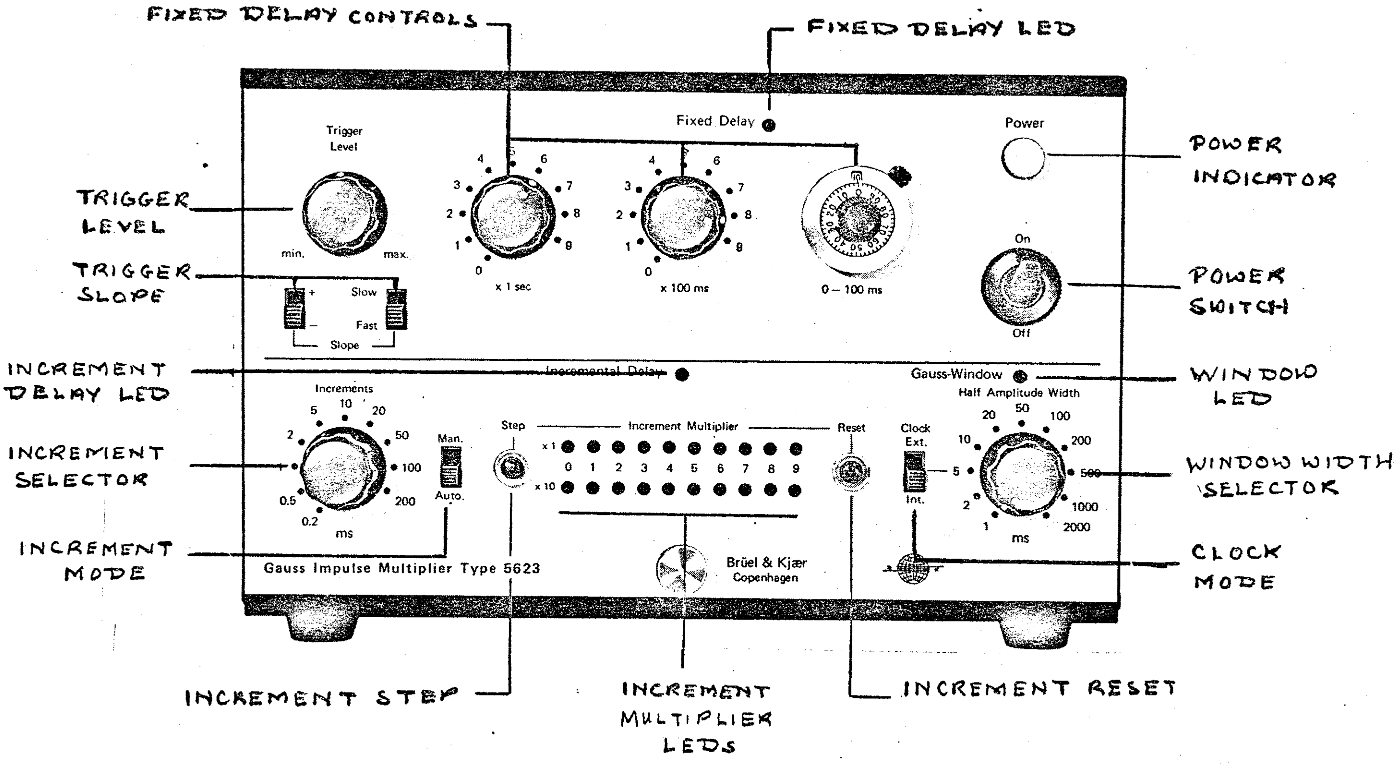


Fig 2.1

Fig 2.2.

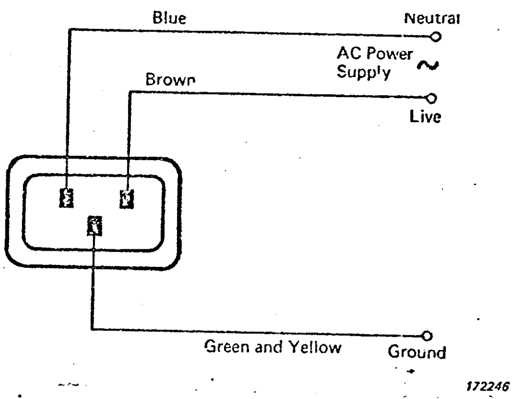
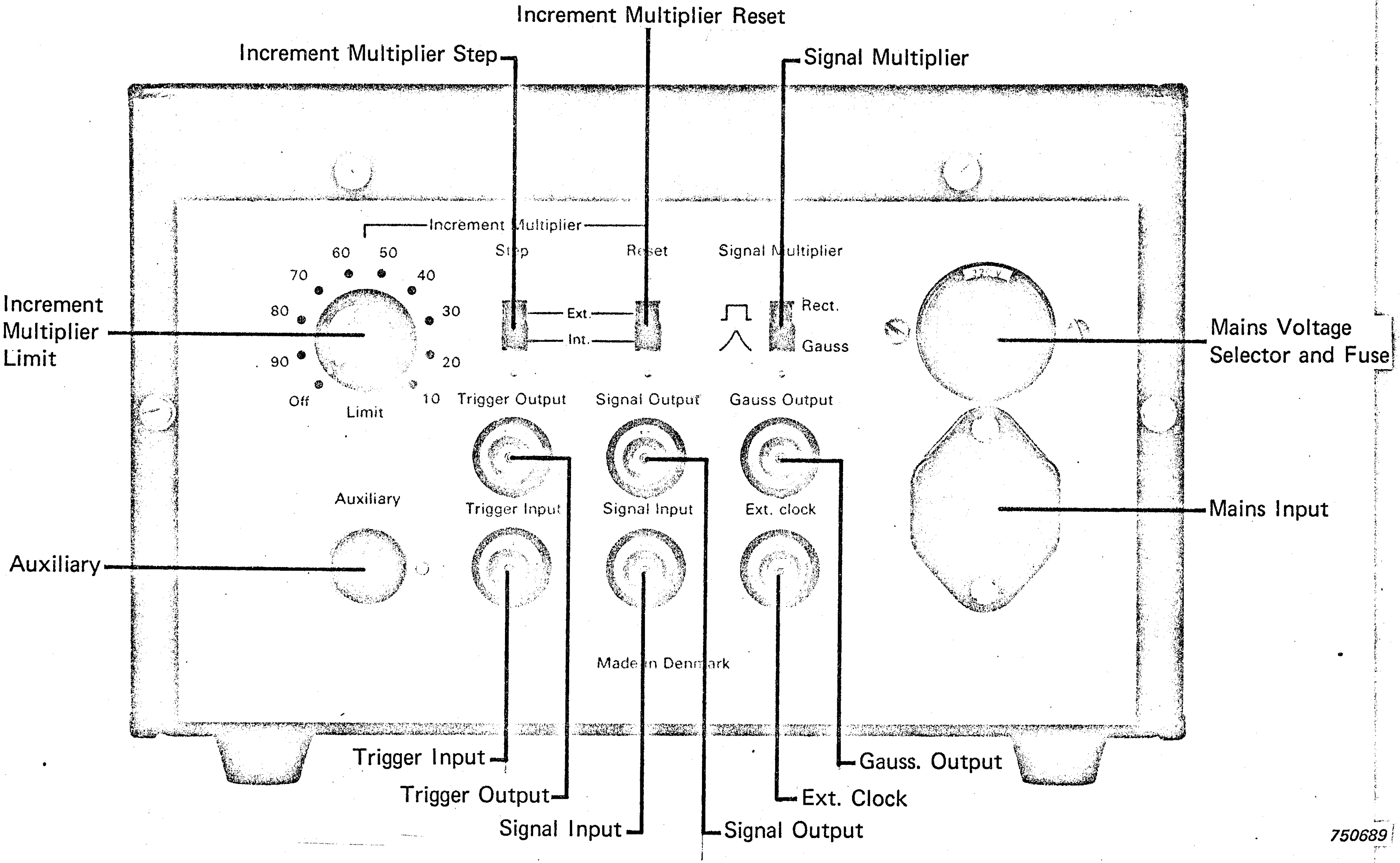


Fig 2.3



750689

750689

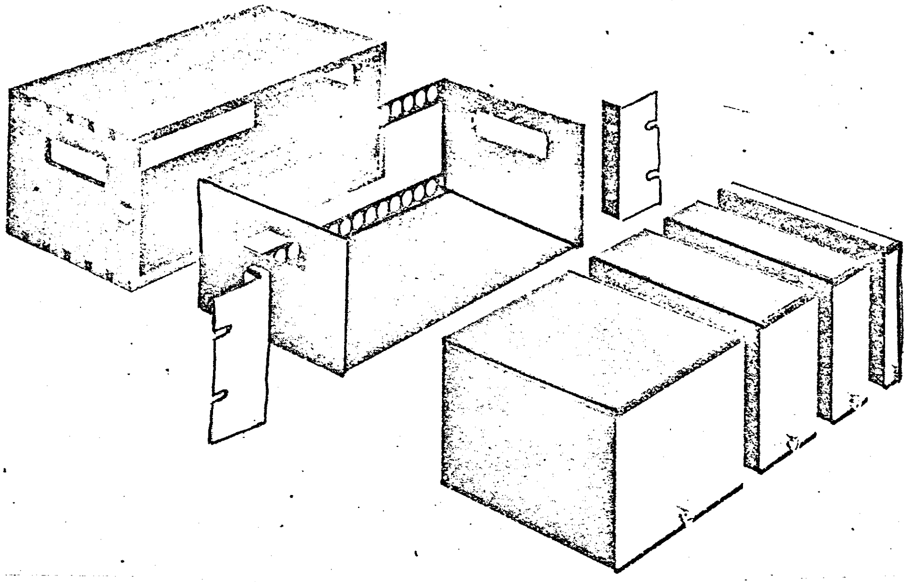


Fig 3.1.

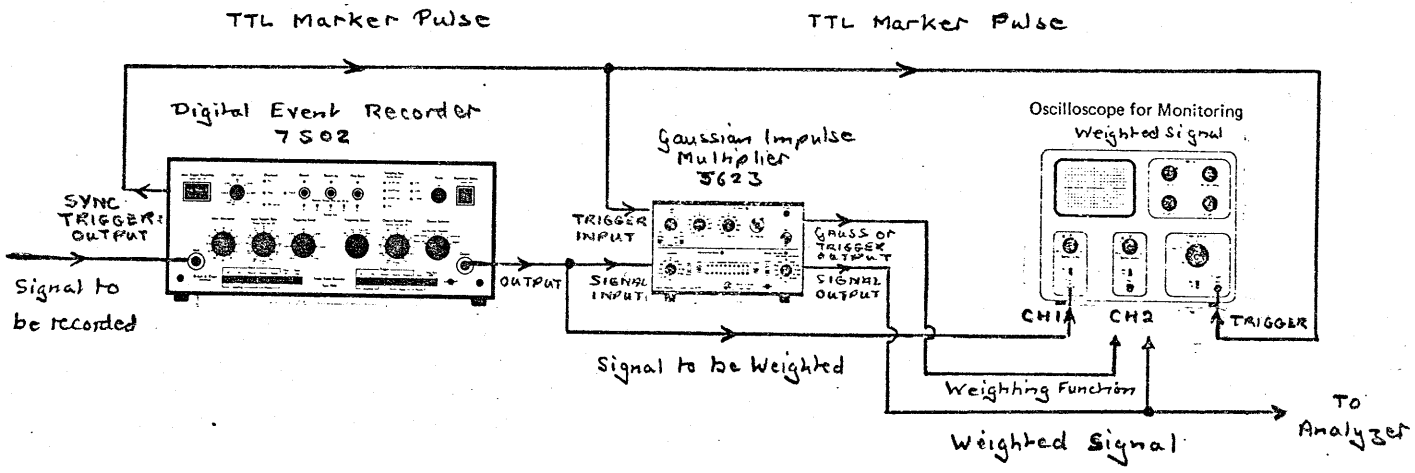


Fig 3.2.

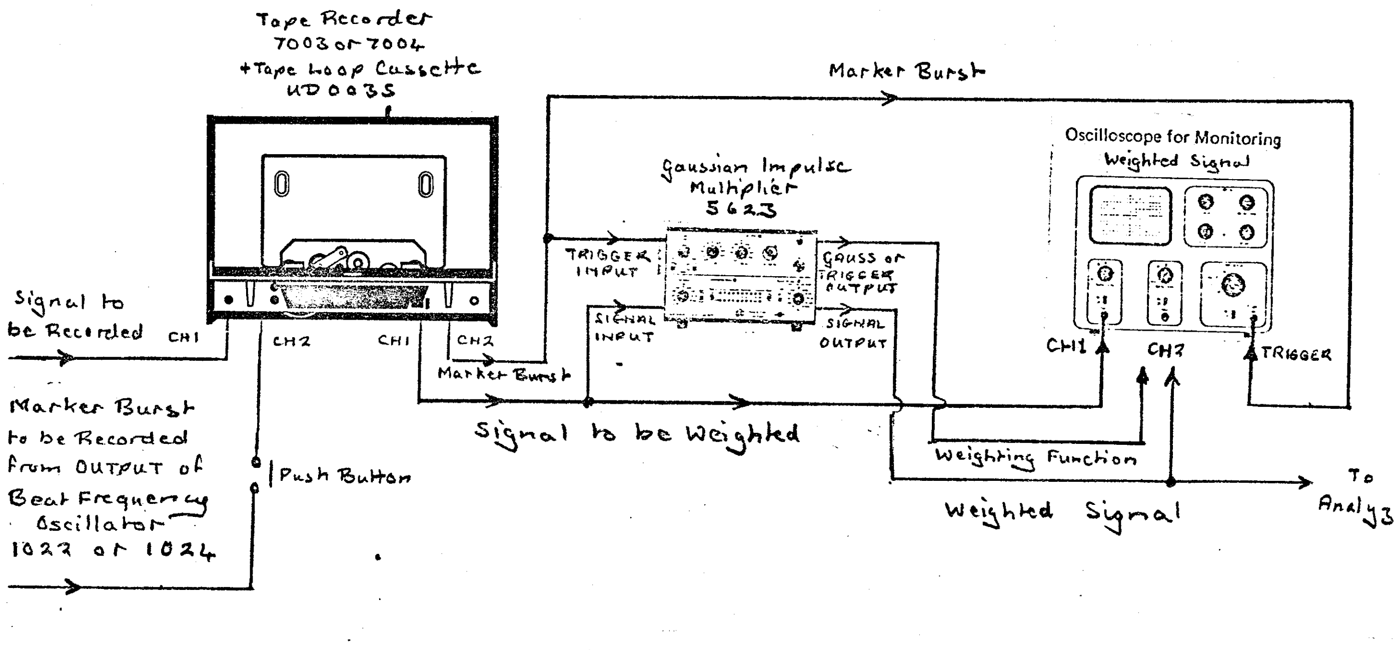


Fig 3.5

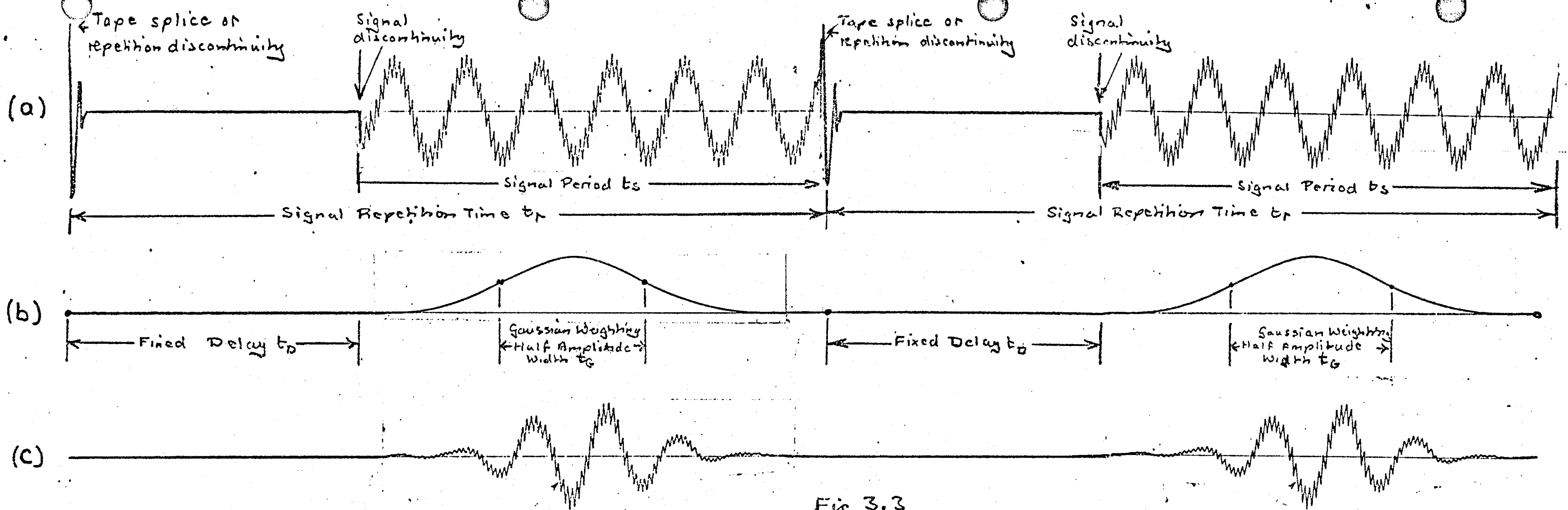

(a)
Tape splice or repetition discontinuity
Signal discontinuity
Tape splice or repetition discontinuity
Signal discontinuity
Signal Period t_s
Signal Period t_s
Signal Repetition Time t_r
Signal Repetition Time t_r
(b)
Fixed Delay t_D
Gaussian Weighting Half Amplitude Width t_G
Fixed Delay t_D
Gaussian Weighting Half Amplitude Width t_G
(c)

Fig 3.3

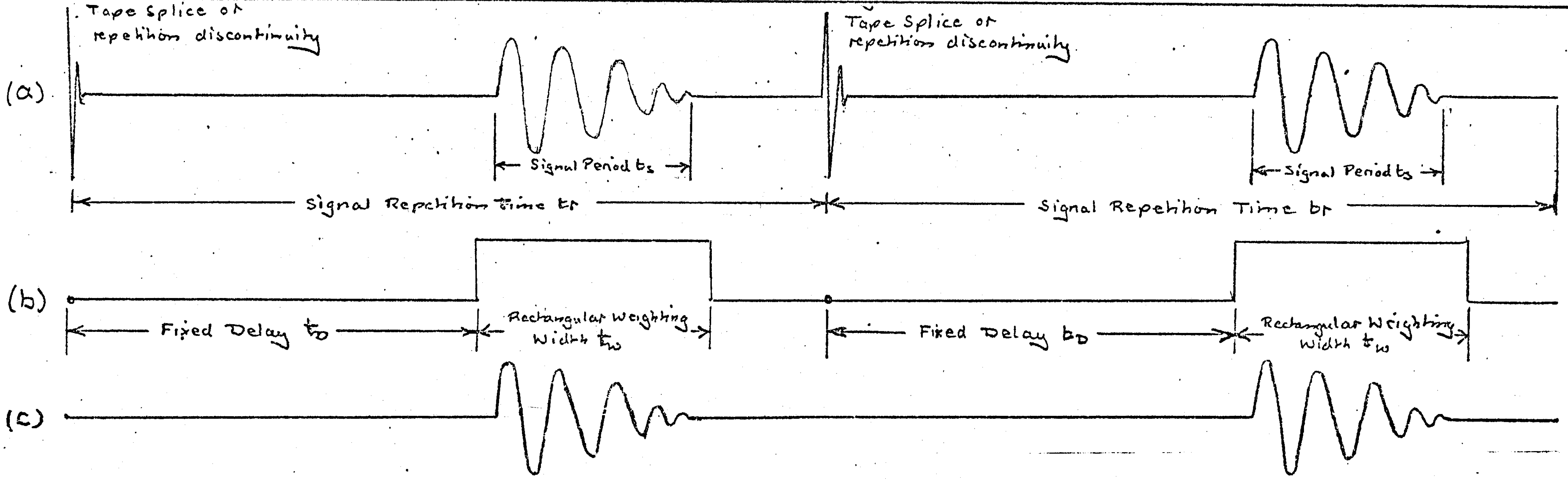

Tape splice or repetition discontinuity
Tape Splice or repetition discontinuity
(a)
Signal Period t_s
Signal Period t_s
Signal Repetition Time t_r
Signal Repetition Time t_r
(b)
Fixed Delay t_D
Rectangular Weighting Width t_w
Fixed Delay t_D
Rectangular Weighting Width t_w
(c)

Fig 3.4

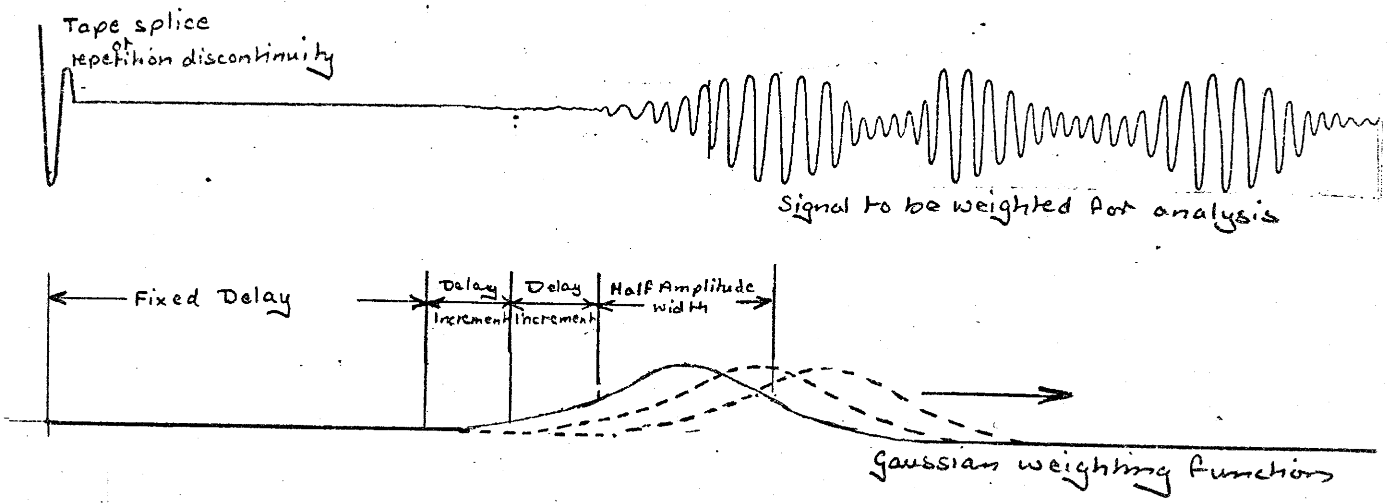

Tape splice or repetition discontinuity
Signal to be weighted for analysis
Fixed Delay
Delay Increment
Delay Increment
Half Amplitude width
Gaussian weighting functions

Fig 3.6.

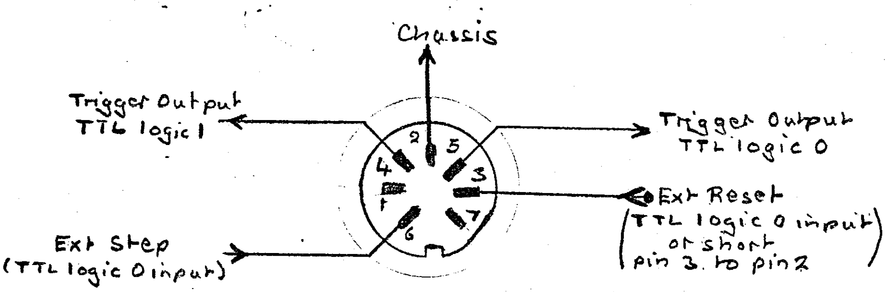

Chassis
Trigger Output TTL logic 1
Trigger Output TTL logic 0
Ext Reset (TTL logic 0 input or short pin 3 to pin 2)
Ext Step (TTL logic 0 input)
2
5
4
3
1
7
6

Fig 3.7

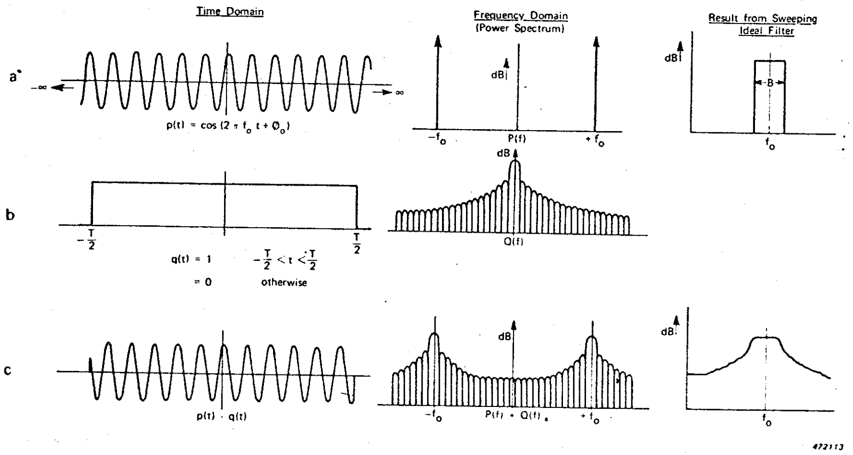


Fig 4.1

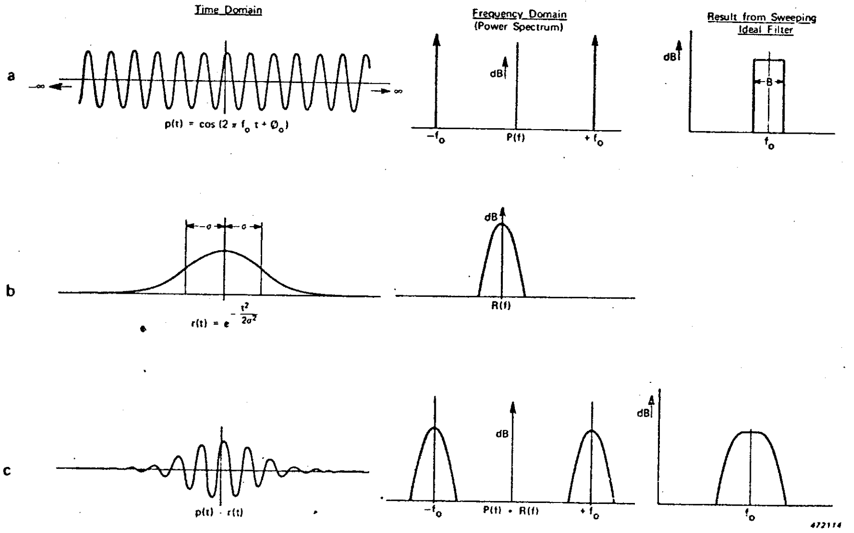
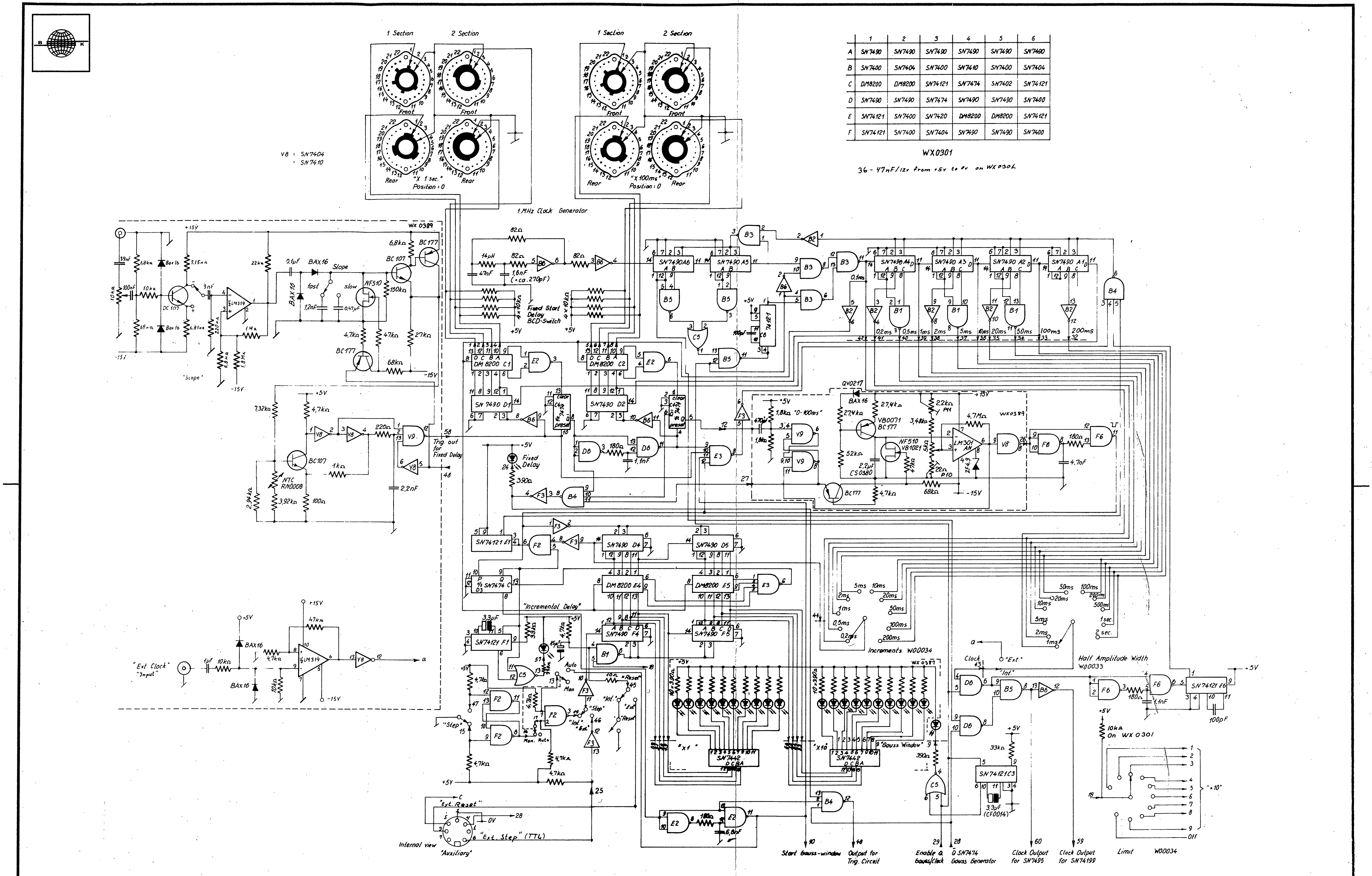


Fig 4.2.



	1	2	3	4	5	6
A	SN7490	SN7490	SN7490	SN7490	SN7490	SN7490
B	SN7400	SN7404	SN7400	SN7410	SN7400	SN7404
C	DM8200	DM8200	SN74121	SN7474	SN7402	SN74121
D	SN7490	SN7490	SN7474	SN7490	SN7490	SN7400
E	SN74121	SN7400	SN7420	DM8200	DM8200	SN74121
F	SN74121	SN7400	SN7404	SN7490	SN7490	SN7400

WX0301

36 - 47nF/12v from +5v to 0v on WX0301

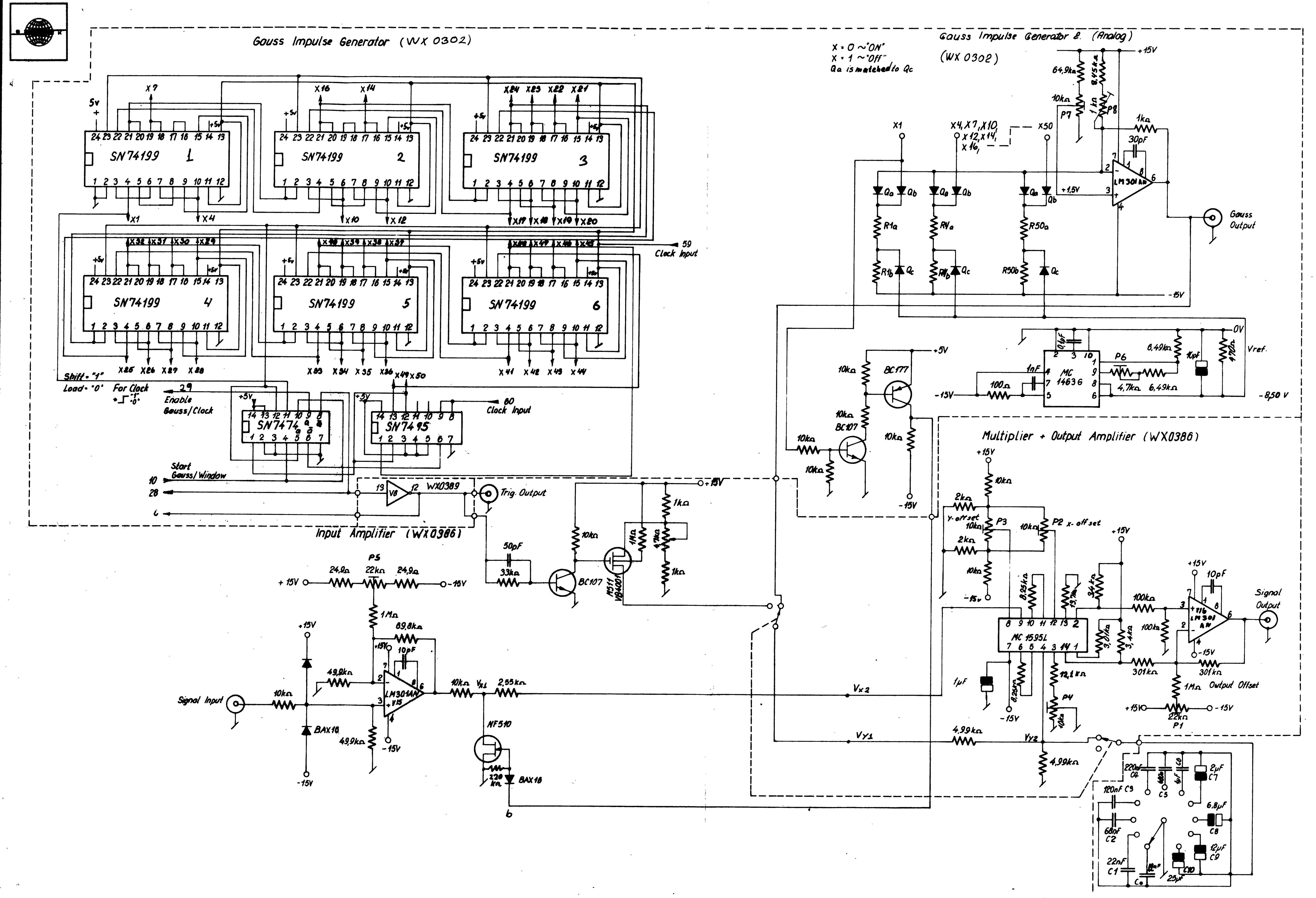
Title Main Control.

Drawn /ILJ. Date 22. 8. 75 Drawing no. WW 0369

Brüel & Kjær
Copenhagen

61-793

This drawing is the property of Brüel & Kjær, Copenhagen



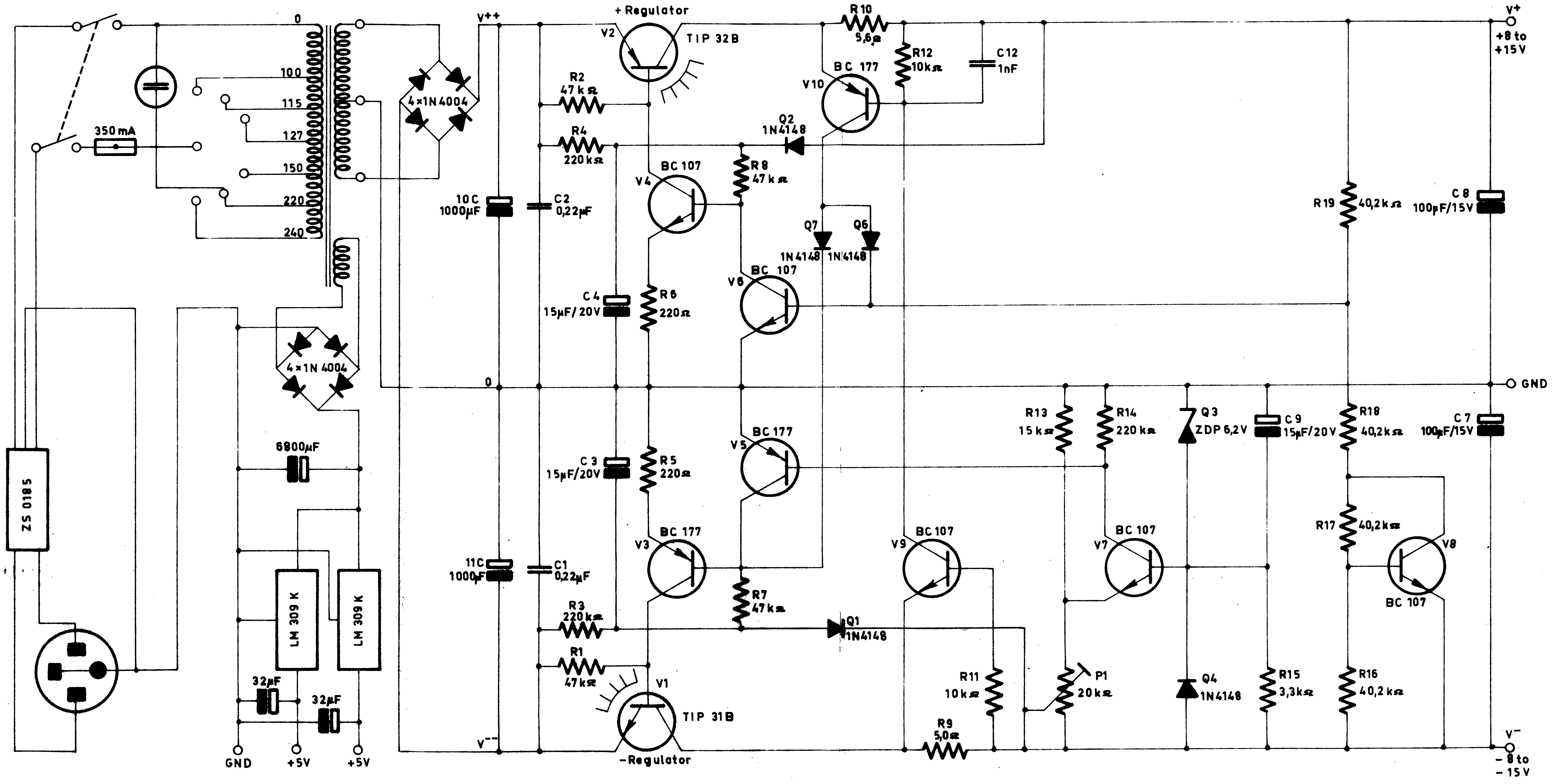
Title Gauss Impulse WO 0033 Type 5623

Drawn /ILJ Date 22.8.75 Drawing no. WW 0368

Brüel & Kjær
Copenhagen

61-793

This drawing is the property of Brüel & Kjær, Copenhagen



Title Dual Polarity Voltage Regulator
Print WX 0613

Drawn KL - RP Date 10 - 7 - 74 Drawing no. WW 0677

Brüel & Kjær
Copenhagen

61-793

This drawing is the property of Brüel & Kjær, Copenhagen

BRÜEL & KJÆR
NÆRUM · DENMARK

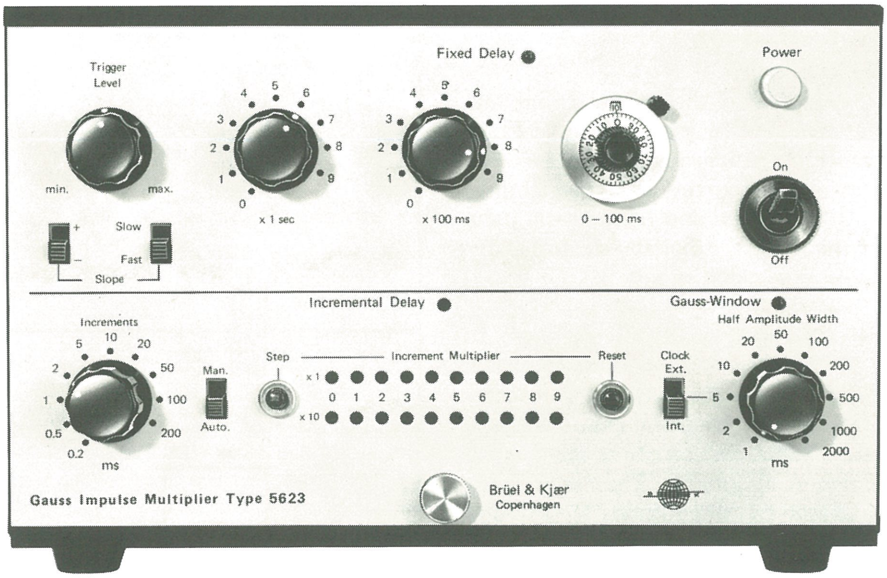
BRÜEL & KJÆR system development

type 5623

Gauss Impulse Multiplier

FEATURES:
- Multiplication of analog signals by a gaussian shaped or rectangular shaped time function
- Generation of gaussian shaped impulses
- Adjustable pulse length
- Built-in adjustable time delay
- Frequency range DC to 20 kHz
- Dynamic range 40 dB

USES:
- Analysis of Instantaneous Spectrum
- Elimination of splice noise on tape loops



It is often necessary during analysis to have information on how the frequency spectrum of a signal changes with respect to time, or to know what the frequency content is at some particular instant. One method of analysis used, is to divide the signal into short time periods and analyse each period separately. This is known as analysis of the Instantaneous Spectrum. The process can also be thought of as multiplying the original signal by a time function which is equal to zero except for a relatively short period. Different shapes of time weighting function can be used and two of these are discussed in Brüel & Kjær Application Note 11–194 Instantaneous Spectrum Analysis with the Real-Time Third-Octave Analyzer (Edition 2).

The Note concludes that a square shaped weighting function is easy to produce by switching the signal on and off, but it can exhibit disadvantages because of the many side lobes in the square function's frequency spectrum. These side lobes can be avoided by using a gaussian shaped time weighting function. This has the additional advantage that the Instantaneous Spectrum is almost independent of the window function's position in time relative to the input signal, provided that the "half amplitude width" of the gaussian function is longer than the periodic time of the input signal.

The same basic principle can be applied to the analysis of continuous signals on tape loops, thus eliminating the effects of splice noise. This is discussed further in Application Note No. 12–036, Stationary Signal Analysis on Tape Loops.

The Type 5623 Gauss Impulse Multiplier is a special instrument designed to produce gaussian shaped time functions and perform the multiplication. It can also be switched to give a rectangular shaped time weighting function.

Description

The instrument consists of Trigger Circuit, Delay Circuits, Clock, Gauss Impulse Generator and Signal Multiplier. A block diagram of the Type 5623 is shown in Fig.1 and a functional sequence diagram in Fig.2. The various stages in the functional sequence can be followed on a series of light emitting diodes (LEDs) on the instrument front panel.

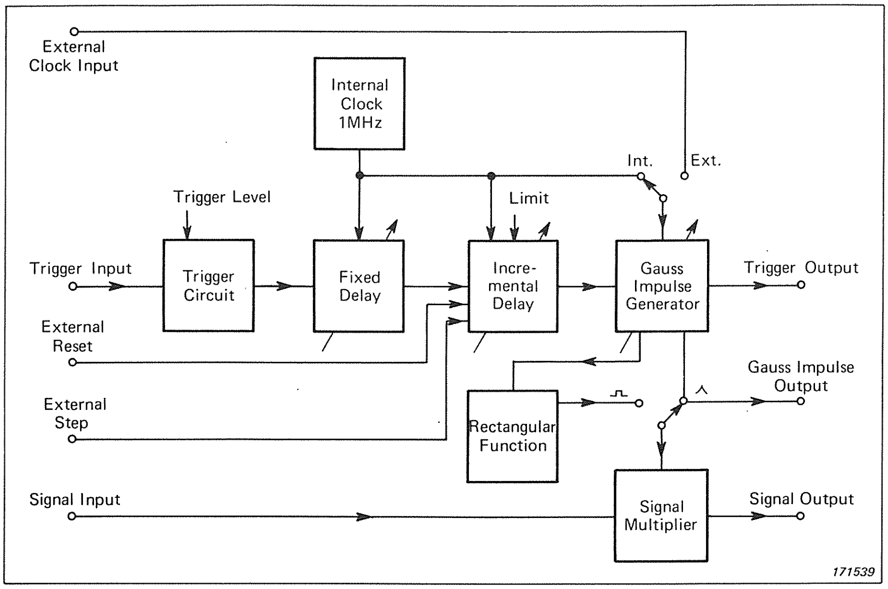


Fig.1. Block diagram of Type 5623

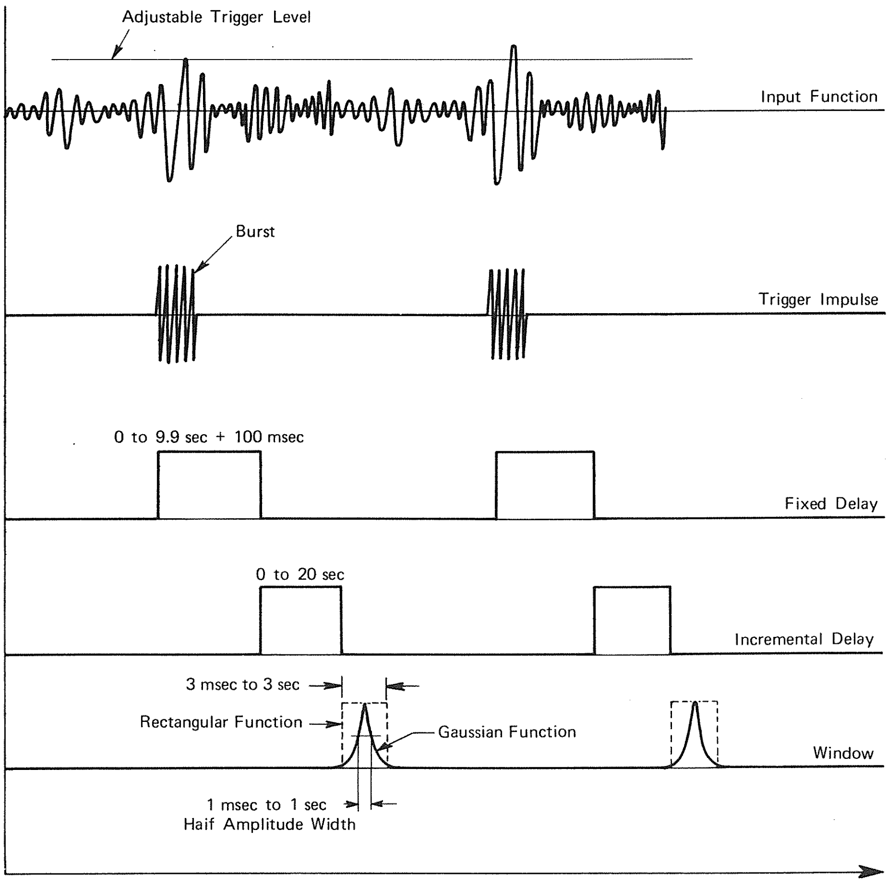


Fig.2. Functional sequence for Type 5623

Trigger Circuit

This unit reacts to a trigger impulse, for example a burst recorded on one channel of a tape loop just before the signal to be analysed appears on the other channel. The trigger level can be adjusted to be sensitive only to the highest peak in the trigger signal's regular time sequence. This also makes it possible to use some high peak in the input signal as a trigger source without other peaks causing false triggering.

Delay Circuits

A signal to the Trigger Input line initiates a two part delay function before the gaussian window opens. For maximum accuracy and repeatability, both the Fixed and Incremental parts of the delay are digitally controlled by an internal clock circuit.

Fixed Delay

This part of the total delay covers the time interval between the occurance of the trigger impulse and the start of that portion of the input signal which is of interest. The Fixed Delay is preset by three knobs to give any delay time up to 10 sec. Two of the knobs select calibrated time interval steps which are digitally controlled by the clock circuitry. The third knob, which is connected to a multiturn potentiometer, controls a maximum of 100 msec of the delay and is fitted with a locking device to prevent accidental movement after setting. These features give a stable delay time and ensure accurate repeatability.

Incremental Delay

Added at the end of the Fixed Delay, the Incremental Delay is the part of the total delay time that is varied to displace the gaussian window function in time with respect to the input signal of interest. After each repetition of the input signal, the position of the gaussian impulse can be either manually or automatically stepped to the next position in accordance with the selected time increment, to give a longer total delay. The Incremental Delay time can readily be determined from the Incremental Multiplier where a LED will light to indicate the factor by which the selected Increment time must be multiplied.

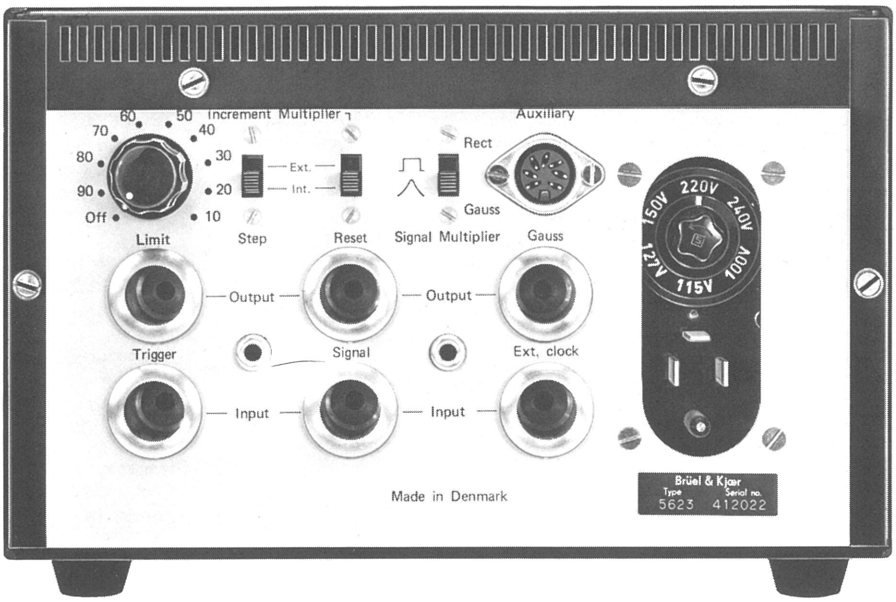


Fig.3. Rear view of Type 5623

The Incremental Delay is digitally controlled by the clock circuit giving increments between 0.2 msec and 200 msec and up to 99 steps on the Increment Multiplier. The actual number of steps taken can be limited by a control knob (LIMIT) on the rear panel of the instrument. When the Incremental Delay reaches the number set, it starts automatically to step from zero again.

Gaussian Generator

The gaussian impulse is generated by the summation of the current from a series of diode switches controlled by a 51 bit shift-left-shift-right register. This shift operation is controlled by the clock circuitry and the gaussian impulse requires a complete shift-left-shift-right sequence of 101 cycles from the clock. The "half amplitude width" is given by the time for 33 clock cycles. The built-in clock oscillator has a frequency of 1 MHz which is divided to give "half amplitude widths" in steps between 1 msec and 2 sec. An external oscillator can be used when the required impulse length falls between the available steps. When used with an external signal, one shift of the register requires one cycle from the generator. As the same knob which selects the window length also controls the smoothing of the steps in the gaussian impulse caused by the addition of discreet current increments, it should be set to the nearest higher position when the instrument is operated with an external clock.

Rectangular Function

The shift-left-shift-right sequence in the Gaussian Generator can also be selected by a switch to control a rectangular shaped weighting function that operates through the Signal Multiplier to open and close the signal circuit. The full register sequence, 101 cycles, is used so the rectangular window is three times the "half amplitude width" of the gaussian signal, and in consequence the times shown on the control HALF AMPLITUDE WIDTH should be multiplied by three when the instrument is used as a rectangular wave multiplier.

Multiplying Circuit

The multiplier actually performs the analog multiplication of the signal to be analysed with the gaussian function or rectangular function. The resultant signal is transferred to the output socket where it is available for analysis. The gaussian time function is also available at an output socket.

Specifications 5623

Trigger Input:

Trigger level adjustable on front panel. MIN: 150 mV peak, MAX: 35 V peak.

Input Impedance: 10 kΩ.

Trigger Slope SLOW: burst input to trigger circuit will cause triggering after approximately 75 msec of a 440 Hz sine burst. (Designed for use with 440 Hz marker on voice channel of Tape Recorder Type 7001).

Trigger Slope FAST: triggering is obtained on either positive or negative going edge of input signal. Slope polarity is given by the "± Selector".

Total Delay:

Total delay between trigger and gaussian window is given by the sum of the "Fixed Delay" and "Incremental Delay".

Fixed Delay:

Total Range: 0 to 10 sec.

The delay adjustment is given by three knobs:

1) 0 to 9 sec in 1 sec increments,
2) 0 to 900 msec in 100 msec increments,
3) 0 to 100 msec, adjusted by a ten turn potentiometer.

An indicator lights to show when the Fixed Delay is active.

Incremental Delay:

Total Range: 0 to 19.8 sec.

Active delay time is given by multiplying the selected time "Increment" by the value indicated on the "Increment Multiplier".

Increment selector: ten positions, 0.2, 0.5, 1, 2, 5, 10, 20, 50, 100, 200 msec.

An indicator lights to show when the Incremental Delay is active.

Increment Multiplier: 0 to 99 arranged as a two decade decimal display using LED indicators.

Gaussian Window:

Total window width: 101 cycles from internal or external clock.

Half Amplitude Width: 33 clock cycles.

An indicator lights to show when the Gaussian Window is active.

Rectangular Window:

Total window width: 101 cycles from internal or external clock. The "Gauss Window" lamp lights when the rectangular window is active.

Internal Clock:

Half Amplitude Width of the Gaussian Window is selected by an eleven position knob, 1, 2, 5, 10, 20, 50, 100, 200, 500, 1000, 2000 msec. These widths are three times longer for the Rectangular Window

External Clock:

Frequency Range 0 to 1 MHz gives Half Amplitude Widths adjustable down to 0.03 msec.

Input Impedance: 20 kΩ.

Input Voltage: 1 to 10 V peak to peak, sine or square wave.

Signal Input:

Input Impedance: 60 kΩ.

Maximum Input Voltage: 2.5 V peak.

Frequency Range: DC to 20 kHz.

Signal Output:

Input to Output Gain at window centre: 0 ± 1 dB.

Output Impedance: < 5 Ω.

Maximum Output Current: 10 mA.

Dynamic Range: 40 dB.

Gauss Impulse Output:

Impulse Peak Voltage: 10 V.

Minimum loading: 10 kΩ.

Trigger Output:

TTL logic "1" during active period of window.

Logic "0" outside the window.

Timebase:

All internal timing is controlled by a built in clock oscillator, Frequency: 1 MHz.

Internal Trigger Inhibit:

Once the delay sequence has been initiated, logic circuitry inhibits retriggering until the window has closed again.

Power Supply:

100, 115, 127, 150, 220, or 240 V AC 50 to 400 Hz.

Power Consumption: approx. 25 W.

Dimensions:

Height: 133 mm (5.2 in)
Width: 210 mm (8.3 in)
Depth: 200 mm (7.9 in)
Weight: approx. 1 kg (2.2 lb).

This instrument is a development of the Brüel & Kjær Systems Engineering Group and is not a standard production instrument. Specifications can be modified, on a contract basis, to meet individual requirements.

For prices and delivery times, please contact your local representative.

Brüel & Kjær

DK-2850 NÆRUM, DENMARK · TELEPH.: (01) 80 05 00 · CABLE: BRUKJA, COPENHAGEN · TELEX: 15316

ORBOE PRINT . COPENHAGEN . DENMARK